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APPLICATION NUMBER: *60/525,578*
FILING DATE: *November 26, 2003*
RELATED PCT APPLICATION NUMBER: *PCT/US04/39515*

Certified by

Jon W Dudas

Acting Under Secretary of Commerce
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17858 U.S.PTO 60/525578 112603

PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EV268210802US

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Keith R.	Minnich	Pewaukee, Wisconsin

Additional inventors are being named on the 2 of 2 *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (500 characters max)

Direct all correspondence to: **CORRESPONDENCE ADDRESS**

☑ Customer Number: 26753

OR

☐ Firm or Individual Name	Thomas M. Wozny				
Address	Andrus, Sceales, Starke & Sawall, LLP				
Address	100 East Wisconsin Avenue, Suite 1100				
City	Milwaukee	State	WI	Zip	53202-4178
Country	USA	Telephone	414-271-7590	Fax	414-271-5770

ENCLOSED APPLICATION PARTS *(check all that apply)*

☑ Specification *Number of Pages* 6 ☐ CD(s), Number _____

☑ Drawing(s) *Number of Sheets* 1 ☑ Other (specify) Return Receipt Postcard

☐ Application Date Sheet. See 37 CFR 1.76

METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT

☑ Applicant claims small entity status. See 37 CFR 1.27.

☑ A check or money order is enclosed to cover the filing fees.

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☐ Payment by credit card. Form PTO-2038 is attached.

FILING FEE Amount ($): $80.00

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.

☑ No.

☐ Yes, the name of the U.S. Government agency and the Government contract number are: _____

Respectfully submitted,

SIGNATURE Thomas M. Wozny

Date November 26, 2003

REGISTRATION NO. 28,922 *(if appropriate)*

Docket Number: 4553-00005

TYPED or PRINTED NAME Thomas M. Wozny

TELEPHONE 414-271-7590

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Docket Number 4553-00005

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any])	Family or Surname	Residence (City and either State or Foreign Country)
Mark C.	Nicholson	Pewaukee, Wisconsin
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Richard M.	Schoen	Hartland, Wisconsin

Number 2 of 2

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FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☑ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT ($) 80.00

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Keith R. Minnich
Examiner Name	
Art Unit	
Attorney Docket No.	4553-00005

METHOD OF PAYMENT *(check all that apply)*

☑ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None

☐ Deposit Account:

Deposit Account Number: 01.2000

Deposit Account Name: Andrus, Sceales, Starke & Sawall, LLP

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	$80.00

SUBTOTAL (1) ($) 80.00

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

	Extra Claims		Fee from below		Fee Paid
Total Claims		-20** =		X	= 0
Independent Claims		- 3** =		X	= 0
Multiple Dependent					= 0

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0.00

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FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) _____

*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) 0.00

SUBMITTED BY				(Complete *(if applicable)*)	
Name (Print/Type)	Thomas M. Wozny	*Registration No. (Attorney/Agent)*	28,922	*Telephone*	
Signature	Thomas M. Wozny			*Date*	November 26, 2003

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METHOD FOR PRODUCTION OF HIGH PRESSURE STEAM FROM PRODUCED WATER WITH ZERO LIQUID DISCHARGE

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Attorney Docket No.: 4553-00005

METHOD FOR PRODUCTION OF HIGH PRESSURE STEAM FROM PRODUCED WATER WITH ZERO LIQUID DISCHARGE

BACKGROUND OF THE INVENTION

[0001] The present invention relates to using produced water obtained from oil well production fluids to generate steam, and more particularly to an evaporation based zero liquid discharge (ZLD) method for generation of high pressure steam from produced water.

[0002] The injection of steam into geologic formations to permit or enhance the recovery of fossil fuels is an established practice. The steam is typically generated in special purpose steam generators from produced water. The current practice has several disadvantages:

[0003] 1. The produced water requires treatment that generates large quantities of waste for disposal.

[0004] 2. Only a portion of the produced water can be recovered. A source of clean makeup water is required to replace the produced water that cannot be recovered.

[0005] 3. The produced water that is not recovered becomes a waste that must be disposed.

[0006] 4. Even after treatment, the produced water can cause scaling or fouling in the steam generator which degrades the steam generation performance and requires significant maintenance and cleaning.

SUMMARY OF THE INVENTION

[0007] An evaporation based ZLD method for generation of 100% high pressure steam from produced water in the heavy oil production industry. De-oiled produced water is processed through an ion exchange system to remove multivalent cations, acidified if necessary, and then decarbonated prior to treatment in a high pH/high pressure evaporator. The vapor produced is suitable, as is, for the steam assisted gravity drainage (SAGD) method which is being utilized by heavy oil

recovery installations. Evaporator blowdown is further treated in a crystallizer to provide a ZLD system. Recovery ratios in excess of 98% are achievable with most produced waters.

[0008] The process described herein has the following advantages over current practice:

[0009] 1. A conventional boiler can be used to convert fossil fuel to steam. The fired boiler operates on high quality demineralized water instead of produced water.

[0010] 2. Higher conversion of produced water to steam is possible.

[0011] 3. Essentially all of the produced water is converted to steam for injection.

[0012] 4. There is a very low wastewater production.

[0013] 5. The process can be complete Zero Liquid Discharge (ZLD).

[0014] 6. The amount of waste produced is less than what is produced by conventional lime soda softening processes.

[0015] 7. Much less energy is required for the process as compared to conventional evaporation technology.

[0016] 8. The process is suitable for high concentrations of silica in the produced water.

[0017] 9. The pH of the feed to the evaporation step is increased to a level where the heat transfer surface operates in a continuous cleaning mode and is not subject to fouling.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] In the drawings:

[0019] Fig. 1 is a flow diagram illustrating the zero liquid discharge process for production of high pressure steam from produced water in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] Produced water, which has been de-oiled according to standard practices, is stream 1. As is well known, "produced water" is water that has been extracted from oil well production fluid. Oil well production fluid refers to the fluid composition obtained from oil wells, and normally includes oil, natural gas and water as well as dissolved materials such as ionic salts, and gases, along with suspended solids, and bacteria . This fluid is treated to remove the gas and oil leaving a separated aqueous stream referred to as "produced water" which contains the above referred to dissolved/suspended materials. Produced water typically contains a ratio of about 2.5 parts water and 1 part oil.

[0021] Softener 2 removes the multivalent ions from the wastewater. The salts of these ions are only slightly soluble. These ions are removed to prevent scale formation in the evaporation steps. Softener 2 can be any of sodium zeolite, sodium form weak acid cation, or any combination of single or two stage sodium zeolite, or sodium form weak acid cation. Calcium, magnesium, strontium, barium, aluminum, iron, manganese and other multivalent ions are reduced to a low concentration. The softener is regenerated using concentrator distillate, stream 28, and regeneration chemicals stream 25. Softener 2 regeneration waste stream 27 is treated in crystallizer 19. The softened produced water is stream 3.

[0022] Stream 3 enters condenser 32. The vapor, stream 4, produced by evaporation in crystallizer 19, which is approximately 10% of the produced water flow, flows into condenser 32. Stream 4 condenses into stream 3 and creates stream 33. This allows recovery of essentially all the available produced water.

[0023] Acid (stream 31) is added to stream 33 to convert alkalinity to carbon dioxide. Stream 33 enters deaerator 5 where the non-hydroxide alkalinity, in the form of carbon dioxide, is reduced to a concentration that is below 10 ppm. The softened, carbonate alkalinity free, produced water is stream 6.

[0024] Caustic soda, stream 24, is added to stream 6 to raise the pH of the produced water.

[0025] Stream 6 can be preheated by hot produced water, or other waste heat source, to improve the overall energy efficiency of the system.

[0026] Stream 6 is mixed with boiler blowdown, stream 14, and then enters evaporator 10. At least 90% of stream 6 is evaporated to produce high pressure steam, stream 11, for injection. Stream 11 is essentially equal in flow to stream 1.

[0027] Fuel, stream 7, is combusted in boiler 8 to produce steam, stream 9, which is condensed in evaporator 10. The condensed steam is returned as condensate, stream 12 to the boiler. A small portion of the condensate, less than 2%, is discharged as blowdown, stream 14. Demineralized water, stream 13, is added to boiler 8 to replace blowdown stream 14. Combustion gases, stream 29, can be further treated to remove pollutants.

[0028] The 10% or less of stream 6 that is not converted into high pressure steam in evaporator 10 enters concentrator 16. Concentrator 16 can be one of or a combination of thin film, natural circulation, or forced circulation design. The heat transfer surface can either be a plate type or tube type. The concentrator is a multiple effect type evaporator. The tube orientation can be either vertical or horizontal. The concentrator is heated with steam flashed from stream 15 as the pressure of stream 15 is reduced upstream of concentrator 16.

[0029] The vapor (steam) produced in concentrator 16 becomes stream 30 and is used to drive evaporation in crystallizer 19. The heating vapor, stream 30, condenses in the heating section of the crystallizer 19.

[0030] The distillate, stream 17, from the concentrator 16 is flashed into the heating section of the crystallizer 19. The distillate, stream 17, and the condensed vapor (steam) of stream 30 are combined in crystallizer 19 and discharged into condenser 32.

[0031] The concentrate from concentrator 16, stream 18, enters the crystallizer 19.

[0032] Crystallizer 19 can be one of or a combination of natural circulation or forced circulation design. The heat transfer surface can either be a plate type or tube type. The tube orientation can be either vertical or horizontal. The

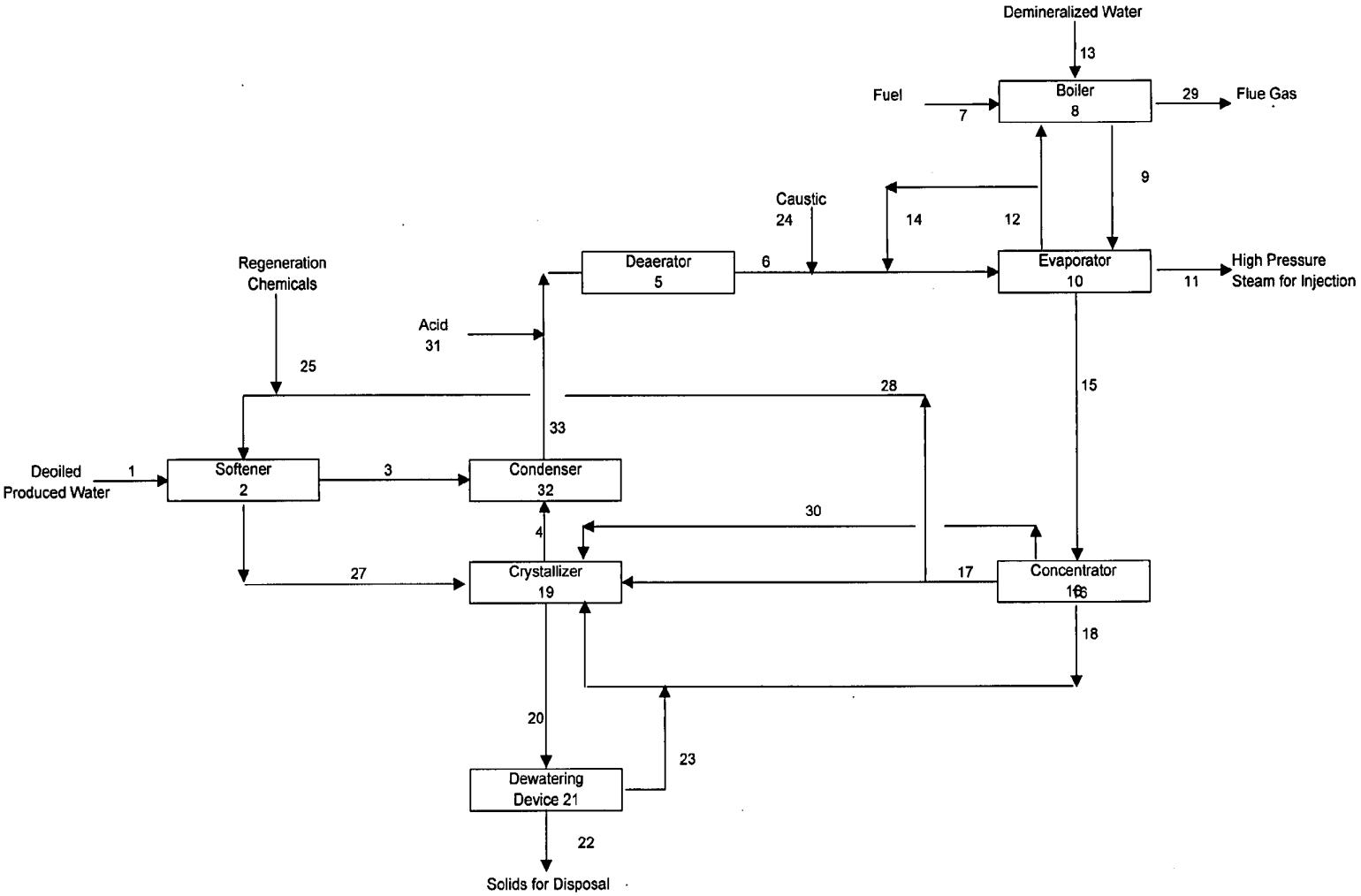
evaporator/crystallizer is direct heated with steam, stream 30, from concentrator 16. The concentrate, stream 20, which includes precipitated salts from the regenerant stream 27 and from evaporator discharge stream 18, from crystallizer 19 can be discharged to an onsite pond or dewatering device 21. Dewatering device 21 can be a belt press, filter press, centrifuge or other commercially available device. The discharge from dewatering device 21, stream 22, is suitable for handling as a solid material for offsite disposal. The filtrate from dewatering device 21, stream 23, is recycled to crystallizer 19.

METHOD FOR PRODUCTION OF HIGH PRESSURE STEAM FROM PRODUCED WATER WITH ZERO LIQUID DISCHARGE

ABSTRACT

An evaporation based zero liquid discharge method for generation of 100% quality high pressure steam from produced water in the heavy oil production industry. De-oiled produced water is processed through an ion exchange system to remove multivalent cations, acidified if necessary, and then decarbonated prior to treatment in a high pH/high pressure evaporator. The vapor produced is suitable, as is, for the steam assisted gravity drainage method being utilized by heavy oil recovery installations. Evaporator blowdown is further treated in a crystallizer to provide a zero liquid discharge system. Recovery ratios in excess of 98% are achievable with most produced waters.

Method for Production of High Pressure Steam from Produced Water with Zero Liquid Discharge
Keith R. Minnich
Attorney Docket No. 4553-00005
Sheet 1 of 1



Method for Production of Steam From Produce Water with Zero Liquid Discharge

Figure 1